Darfur Cookstoves Project

Final Report

5/10/06

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Darfur Cookstove

Latest Events in Darfur

(3/8/06) 30,000 march in Khartoum opposing UN involvement.

(3/10/06) UN decides to take over peacekeeping in Darfur.

Firewood patrols one of the heaviest security operations in Darfur (>3000 IDPs gather firewood/week)

Fuelwood scarcity becoming unbearable – new challenge from UN officers to find alternative fuel (beyond our scope)

Update on Darfur Conflict continued…

- 4/28/06 UN World food program cutting rations *in half* (due to lack of funds).
- 4/30/06 thousands march in Washington D.C., Golden Gate Bridge (we were there!)
- 5/1/06 Latest peace talks fail - deadline extended to Thursday

Darfur Cookstove

Our Goals

Optimum:

1) Modify the Tara cookstove to make it STABLE (ie., not prone to tip over) during the vigorous stirring of assida in round-bottom traditional pot.

3) Modify the Tara cookstove to that it retains HIGH FUEL EFFICIENCY IN WIND as most cooking is done in the open.

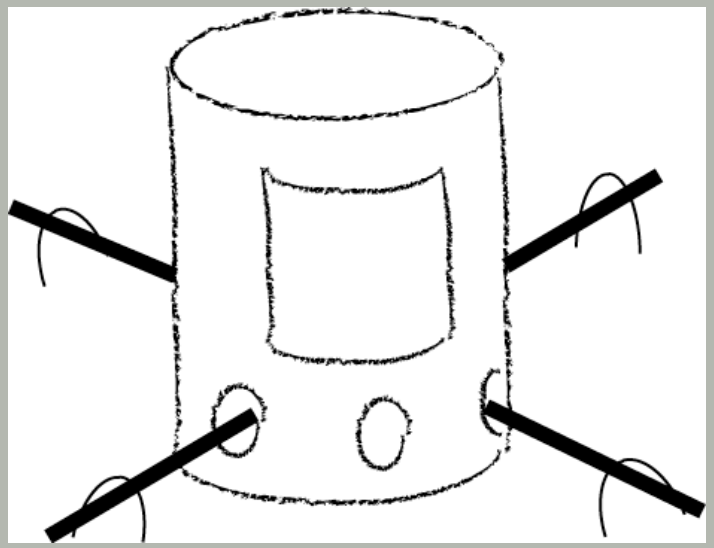
Final design should be *low cost*, easy to make in Darfur, and increase relative *fuel efficiency*.

Minimum: one of the two above

Methods - I

Brainstorm stove design

- low cost, no moving parts



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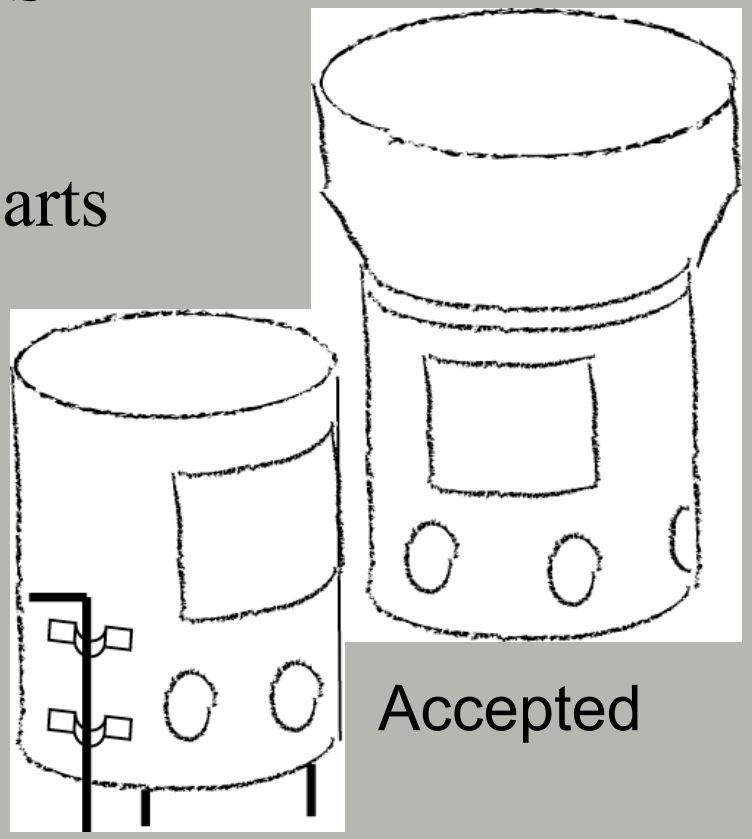


Accepted

Methods - II

- Fabricate a model of the stove design

Assida Pot

Original

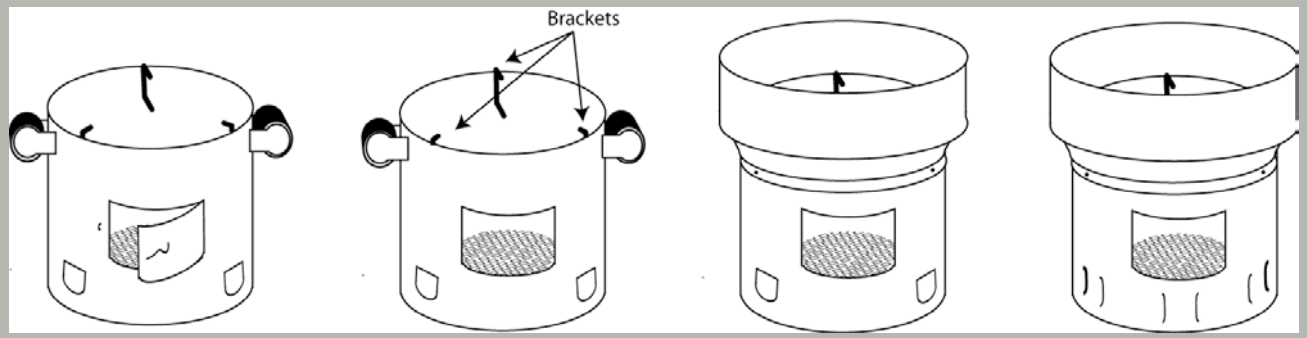
Modified

Mulah pot

Original

Modified

Methods II (continued)

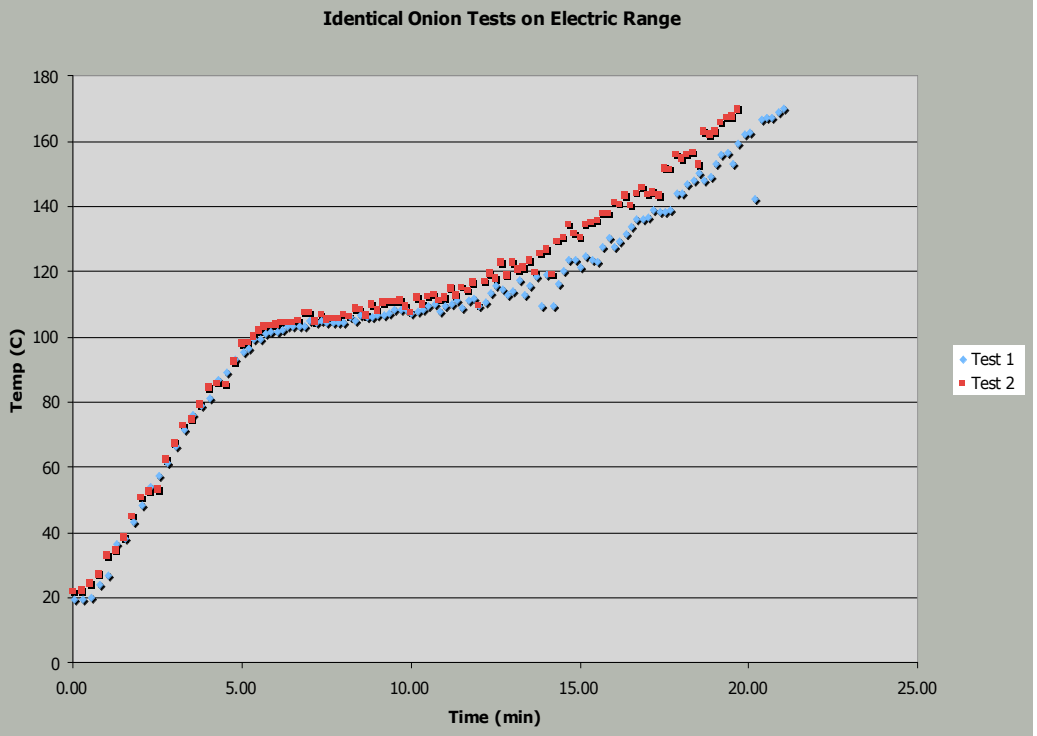


- Brackets reduced sink mullah pot inside
- Wind collar added to the top to prevent breeze interfering with heat transfer
- Bottom vents redesigned to reduce impact of breeze on heat transfer

Methods - III

- Electric Range Test to develop mullah protocol

- Gas Stove- can control flames
- Confirm the chemical process while frying onions
  - Test establishes ‘elbow’, the point where the heat has evaporated the water and is dramatically increases temperature



Methods – IV

- Establish protocol for testing relative efficiency

Assida: water boiling test

-Bring to boil, simmer 15 min

Mulah: onion frying test

- Bring onion/oil mix to 120C

For both tests, compare the wood used for original and modified stoves, with and without a breeze

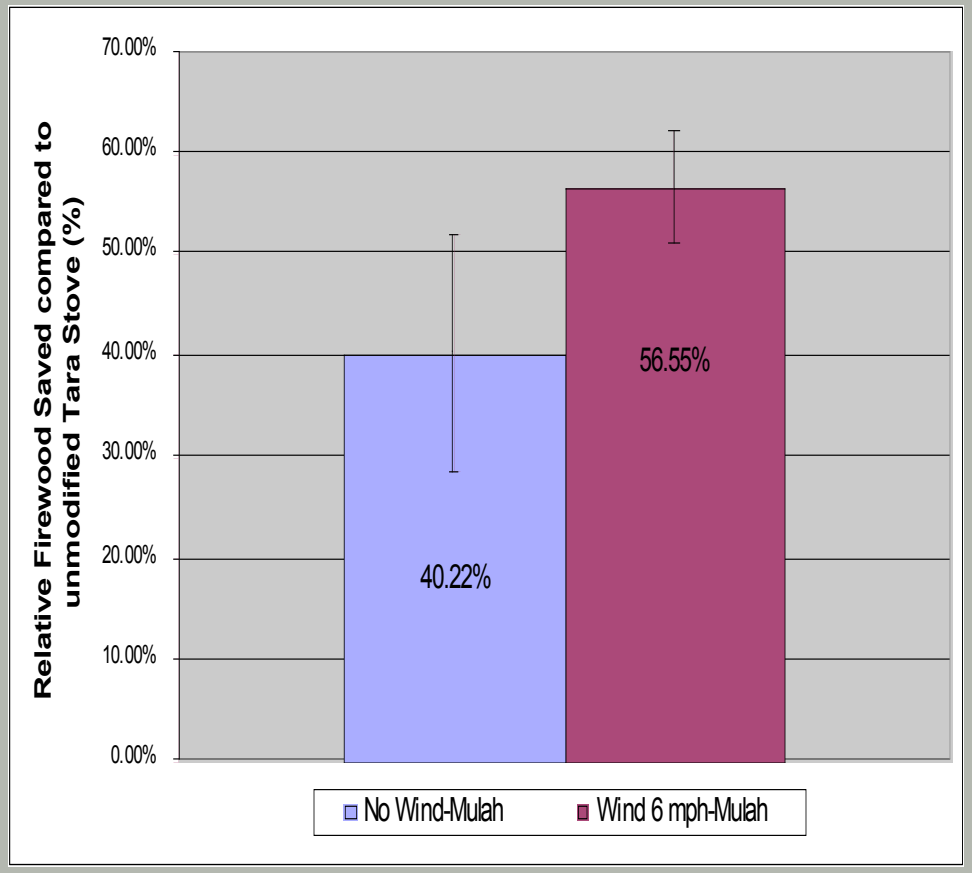
On the learning curve…

Our results were affected by

- Fire tender -- I.e., the cook
- Doubling up - running two stoves at once
- Ambient breeze
- Size and age of chopped onions

Onion-frying Test Results

Mulah with modified and unmodified Tara Stove



- **Calculations**

Increased fuel savings =
[W (unmodified) – W (modified)] / W (unmodified)

Conclusions:

- **40% relative fuelwood savings for Mulah in still air!**
- **57% relative fuelwood savings with a breeze!**

Test Results cont'd: Mulah without wind

	Unmodified Tara		Modified Tara		
Test Date	Time - reach 120C	Fire wood used (g)	Time - reach 120C	Fire wood used (g)	Relative Firewood Savings [Wood (unmodified) - Wood (modified)] x 100/ [Wood (unmodified)] *
3/10/06		171		106	38.01%
3/14/06		302		122	59.60%
4/4/06	23 min	201	17 min	107	46.77%
4/15/06	20 min	215	12 min	132	38.60%
4/18/06	31 min	229	17 min	156	31.88%
4/24/06	35 min	321	32 min	236	26.48%
				Mean	40.22%
				Standard Deviation	11.70%

40.22% relative firewood savings!

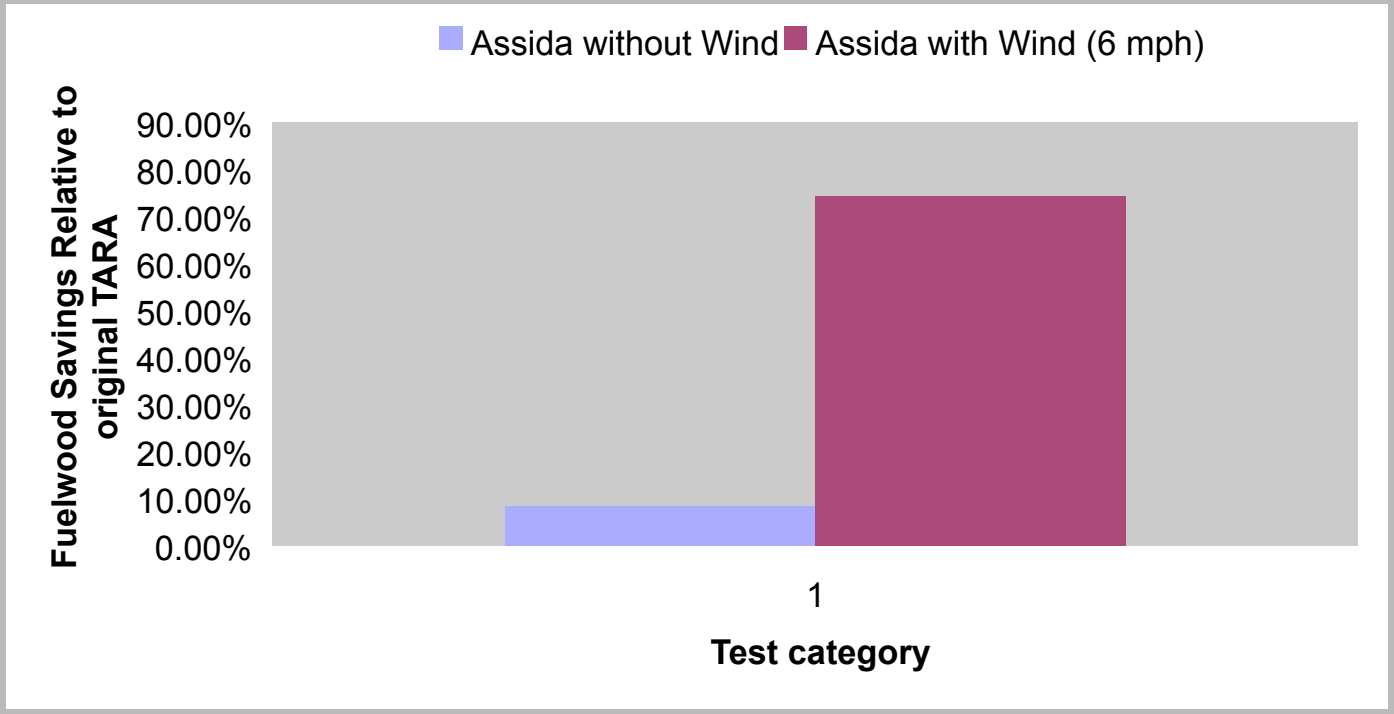
Test Results cont'd: Mulah Test with wind

	Unmodified Tara		Modified Tara		
Test Date	Time-reach 120C	Fire wood used (g)	Time-reach 120C	Fire wood used (g)	Relative Firewood Savings
4/17/06	21 min	354	8 min	175	50.56%
5/1/06	14 min	357	12 min	152	57.42%
5/1/06		313		120	61.66%
				Mean	**56.55%**
				Standard Deviation	**5.60%**

56.55% relative firewood savings!

Water Boiling Test Results

Assida with modified and unmodified Tara Stove



NO WIND	
4/15	9.21%
4/18	10.09%
4/26	5.69%
Mean	**8.33%**
StdDev	**2.33%**

WIND 6 MPH	
4/30	79.73%
5/3	68.88%
Mean	**74.30%**
StdDev	**7.67%**

Conclusions:

- **Minor fuelwood savings in still air (only 8%) - due to poor fit of the large assida pot; hard to fit different pots on one stove top**
- **75% fuelwood savings in presence of breeze!**

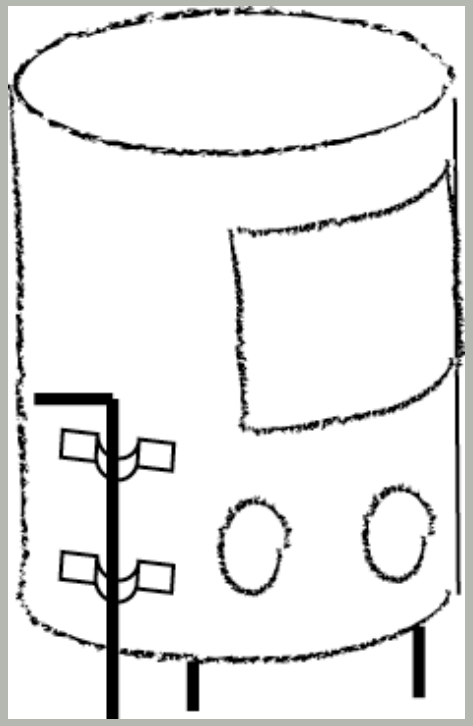
Test Results Summary

Our Modifications work! Improvements over Standard Tara in plain text; savings over a three-stone fire **in bold text**:

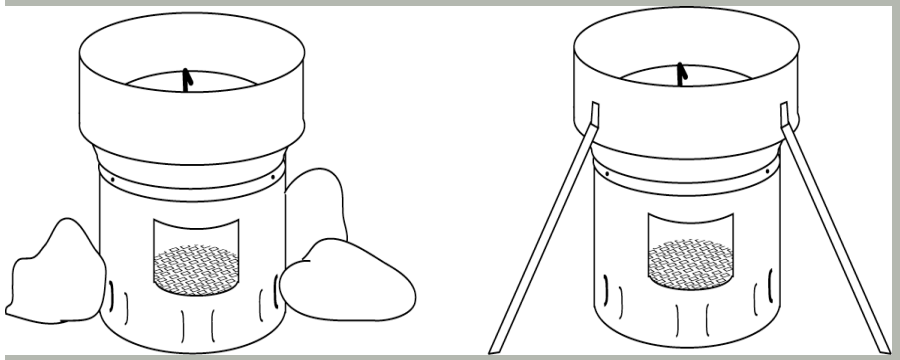
- Mulah
  - 40% fuel savings in still air **(~70% savings over a three stone fire)**
  - 57% fuelwood savings in a strong breeze **(~80% savings over a three stone fire)**
- Assida
  - 8% fuelwood savings in still air **(~55% savings over a three stone fire)**
  - 75% fuelwood savings in a strong breeze **(~88% savings over a three stone fire)**

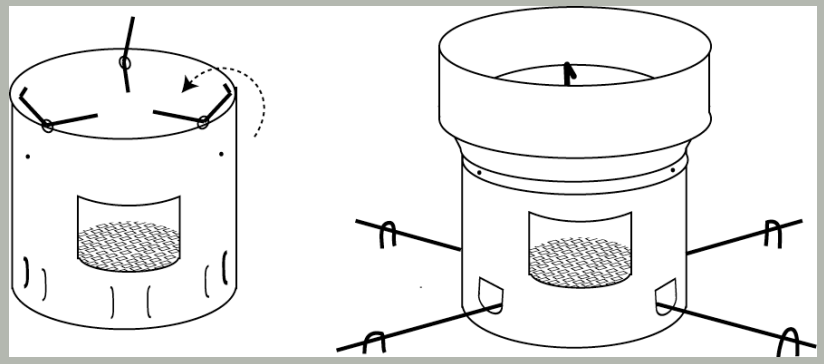
Stability?

- The current stove design lacks stability
- In Dr. Gadgil's November visit, the pot easily tipped over during cooking unless a second person held it down.



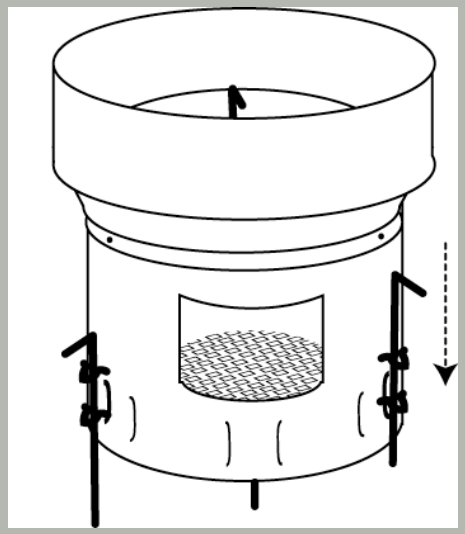
Initial Stability Designs

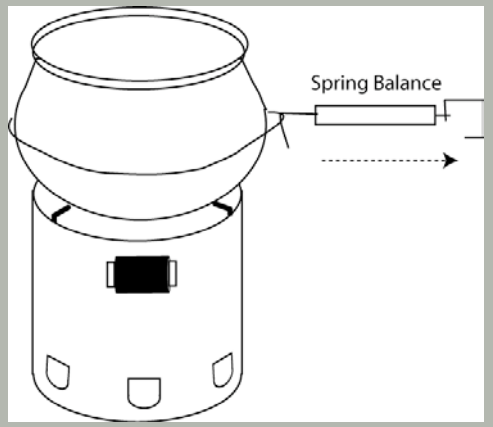




- Stones to provide stability
- Tripod protruding from wind collar
- Swinging hinges locking the pot in place
- Reinforced cross-bars running through the bottom

Final Design





- Stakes attached to stove lock into the ground
- Stakes positioned so stove cannot be operated without driving them into ground
- Original and modified designs tested with the use of mechanical spring balance
- Results: Stakes make the stove over 10x more stable!

Future Work

- **Design stove for mass production locally in Darfur -- June 2006**
- **Cookstove Dissemination**
  CHF: Plan to produce 10,000 stoves this year
- **40,000 in the next year, ultimately 300,000**
- **New Funding Sources being explored : Bears Breaking Boundaries, Chancellor's office, Philanthropic Foundations**

To donate - go to **http://darfurstoves.lbl.gov**